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PRELIMINARY RESTORATION SCOPING ANALYSIS
LCP CHEMICALS SUPERFUND SITE
BRUNSWICK, GEORGIA

Prepared for

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Central Administrative Support Center
Kansas City, Missouri 64106

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1 INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) has prepared this Preliminary Restoration Scoping Analysis for the LCP Chemicals Superfund Site at Brunswick, Georgia under a task order from the National Oceanic and Atmospheric Administration (NOAA), Contract No. 50WCNA906018. This scoping analysis includes evaluation of on-site primary restoration technologies and off-site compensatory restoration. Alternatives were evaluated based on benefits and limitations related to: (1) the extent to which the alternative could return injured resources to baseline with minimal further harm to the environment; (2) the uncertainty of the success of the alternative, including its stage of technical development and previous demonstrated successes; (3) the relative cost effectiveness; (4) permanence, or the need for continued monitoring or institutional controls; and (5) community acceptance. A number of the alternatives presented in this report could be classified as response actions involving removal and remediation, but because these actions can also return injured resources to their baseline condition (condition prior to release of hazardous substances), they may also be classified as primary restoration techniques.

The alternatives presented in this preliminary scoping analysis have not been peer-reviewed and do not represent an exhaustive treatment of all restoration alternatives. Not all identified sources were contacted and some sources contacted did not respond within the time period of this task.

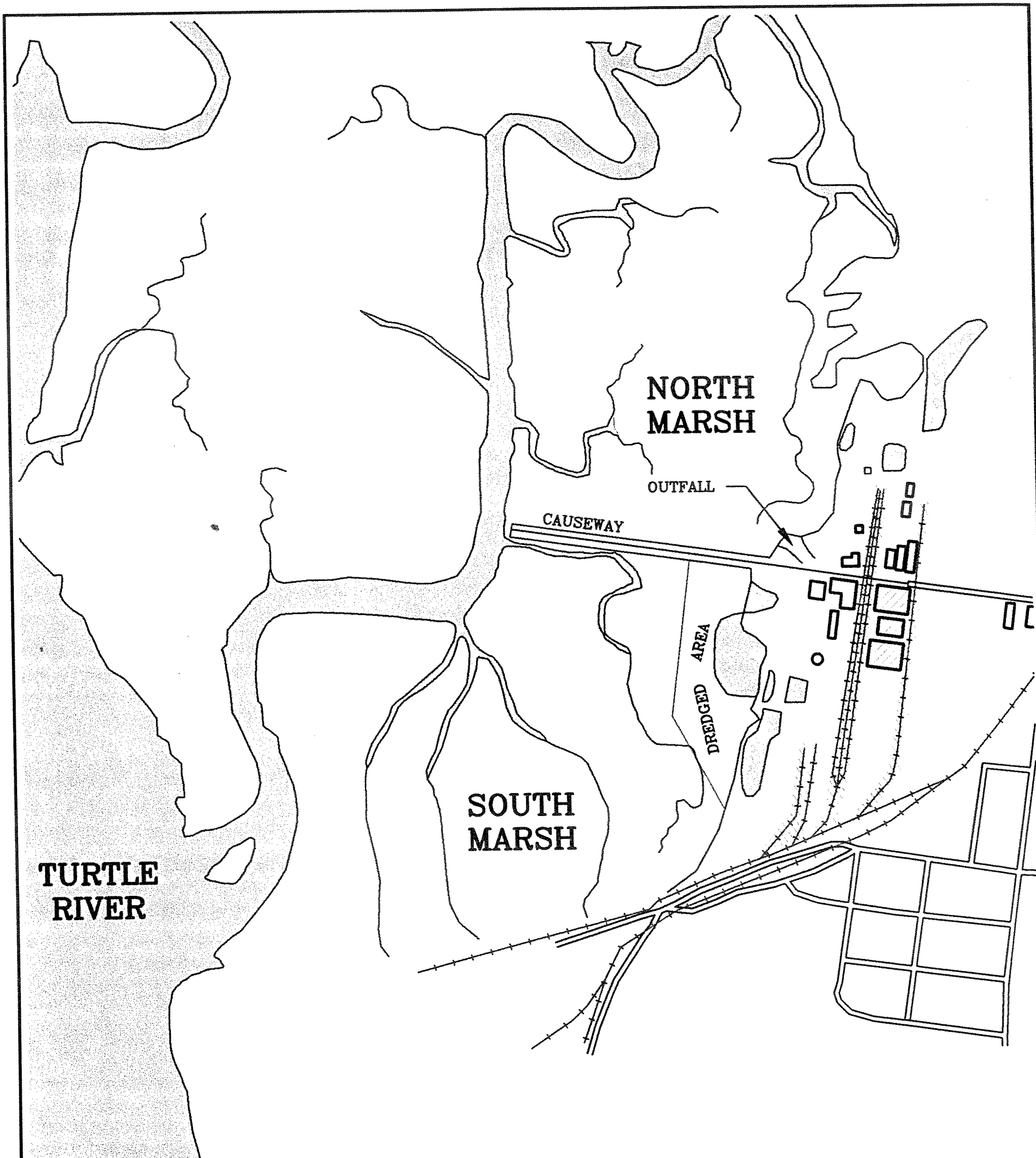
1.1 Site Background

1.1.1 Location/Description

The LCP Chemicals Superfund site (EPA Facility ID: GAD09903182) is located at latitude 31.185368 and longitude –81.504837 on Ross Road in Brunswick, Glynn County, Georgia. The facility is bordered by the Turtle River, creek tributaries and saltmarshes to the west, residential areas to the north and south, and light industry to the east. A topographic map of the facility and environs is provided in Figure 1. About 80 acres of upland contain the former industrial operations of LCP Chemicals Georgia, Inc. A facility layout map is shown in Figure 2. The areas around the facility consist of undeveloped intertidal estuarine wetlands that have been exposed to metals and industrial wastes from the operations. Samples collected at the site indicate that more than 500 acres of saltmarsh sediments and more than 50 acres of creek channel sediments have elevated levels of contaminants (NOAA, 1999b).

1.1.2 Site Use / Operations

Various industrial operations have taken place at the facilities since 1920 resulting in the release of a number of hazardous substances. An oil refinery, a paint manufacturing company, a power plant, and a chlor-alkali plant have all operated at the site over the last 70 years. The site was used from 1955 to 1994 as a chlor-alkali facility, producing caustic soda, chlorine, and hydrochloric acid by the electrolysis of sodium chloride using mercury cells. Polychlorinated biphenyls (PCBs), primarily Aroclor 1268, which is unique to the process, were used as dielectric coatings to protect carbon anodes. Raw materials and products were transported via rail and direct pipelines to adjacent industrial facilities.



LEGEND

- REMOVED STRUCTURES
- FILLED MARSH/ SURFACE IMPOUNDMENT
- EXISTING STRUCTURE
- PROPERTY LINE
- RAILROAD

0 450 900
SCALE IN FEET

N

SOURCE: MODIFIED FROM USGS, BRUNSWICK EAST AND BRUNSWICK WEST, GEORGIA QUADRANGLES, 1993.

LCP CHEMICALS
BRUNSWICK, GEORGIA
PROJECT NUMBER G1063-0019

FIGURE 2
FACILITY LAYOUT MAP

Tetra Tech EM Inc.

(mg/kg). An undisturbed region of saltmarsh between the dredged marsh area and a dredged creek tributary (see Figure 2) showed mercury sediment concentrations ranging from several to more than 40 mg/kg dry weight basis. In addition, post-excavation confirmational samples show mercury concentrations still in excess of 50 mg/kg in the channels. Several areas in the channels also had post-excavation PCB concentrations ranging from 10 to 44 mg/kg.

1.3 Land Use

The saltmarshes and creeks at the site are used for recreational and, potentially, subsistence fishing. They are readily accessible to the public via boat from the Turtle River. The Georgia Department of Natural Resources (GADNR) has issued a health advisory recommending against consumption of recreational captured seafood for Purvis Creek, Gibson Creek, and an area of the Turtle River extending approximately 800 meters upstream and downstream from the mouth of Purvis Creek. All commercial bait shrimping and crabbing are prohibited in this same area as a result of mercury and PCB contamination associated with the LCP Chemical site. Any future remediation or restoration undertaken in the saltmarsh would have to address returning conditions to exposure levels that would permit resumption of fishing activities.

The upland regions of the LCP Chemical site have been used for industrial purposes for several decades. As a result of residual levels of contamination at the site, this area will likely require institutional controls well into the future. These institutional controls, which could include deed restrictions, easements, fencing, etc., would primarily serve to protect humans working or residing on or near the site.

1.4 Ecological Risks

Natural resources are under trusteeship of the Department of the Interior (DOI), represented by its authorized official, the regional director of Region IV (hereinafter, DOI will be referred to as the U.S. Fish and Wildlife Service [USFWS]), NOAA, and the GADNR. These natural resources have been affected, or will potentially be affected, by the contaminants released from the LCP Chemical facility. These natural resources include surface water, groundwater, soils, sediments, fish, wildlife, and other biota. The site includes upland, saltmarsh, and open water habitats that support Federal and State listed threatened and endangered species, migratory birds, wading birds and waterfowl, marine mammals, anadromous fish, and important sport and commercial finfish and shellfish species.

Contaminant levels in sediments throughout the site consistently exceed NOAA's "effects-range-median" (ER-M) (Long, 1995), and post-removal data indicate that remaining levels of mercury and PCBs still exceed these criteria by an order of magnitude or more. Mercury is a known mutagen, teratogen, and carcinogen and at low concentrations has been shown to adversely affect reproduction, growth and development, metabolism, behavior, coordination, and vision (NOAA, 1999b). PCBs exhibit "dioxin-like" biological activity and are known endocrine disruptors They have been shown to be immunotoxic, carcinogenic, and result in adverse affects on reproduction, development, hepatic, and thyroid systems (U.S. EPA, 1993).

2 PRIMARY RESTORATION ALTERNATIVES

2.1 Problem Definition

Industrial practices at the site have resulted in the release of mercury, PCBs (primarily Aroclor 1268), lead, PAHs, and other chemicals. Based on the facility's industrial operations history, the lead and PAHs were primarily released to the environment prior to 1955. Mercury and PCBs were released in larger quantities as recently as 1994. In addition, the releases were often directly into the saltmarsh. Furthermore, by their nature, these contaminants are recalcitrant to physical and chemical degradation, fixation, or other attenuation processes.

2.1.1 Contaminants of Concern and Environmental Fate

Elemental mercury will not breakdown in the environment. It can be attenuated by adsorption, formation of stable, insoluble compounds, or through natural containment or capping processes. Its valence state and the formation of inorganic or organic compounds affect its mobility and toxicity. The most toxic and biologically available form of mercury in the environment is monomethyl mercury (MMHg). Sulfate reducing bacteria (SRB) are believed to control mercury methylation (U.S. EPA, 1998b; Benoit, 1999). The tidal saltmarsh sediments are likely to be anoxic and contain sulfur compounds (U.S. EPA, 1998b). However, site-specific studies are needed to determine the biogeochemical parameters affecting mercury methylation within the saltmarsh sediments.

Aroclor 1268 is a highly chlorinated PCB unique to the chlor-alkali process used at the LCP facility. It consists primarily of octa- and nona-chlorinated biphenyls. Being highly chlorinated, and consisting primarily of congeners with at least two ortho-chlorines, it is very stable and will breakdown slowly in the environment (Kannan, 1997). In addition, its relative lower water solubility and vapor pressure make it less mobile than other Aroclors. These same traits increase the potential for bioaccumulation and biomagnification in the food chain (Maruya, 1998) although little is known of its biotransformations or toxicity. However, studies indicate that PCBs in the LCP marsh and tidal creek sediment have a relatively unaltered congener profile from that of Arochlor 1268, suggesting little breakdown has occurred (Kannan, 1997). As a result of the slow breakdown, Arochlor 1268 contamination is most likely to be attenuated by stabilization, containment, or capping processes similar to those processes presented for mercury.

Both mercury and PCBs adsorb readily onto sediment and colloidal particles. Partitioning is especially strong to those sediments with high organic carbon content. Therefore, both contaminants have their environmental fates tied closely to sediment dynamics. While the LCP marsh sediments are likely considered as highly cohesive and contain high organic carbon content, the shear stresses generated by strong tidal flows and bioturbation could result in significant contaminant mobility through sediment transport.

The breakdown, mobility, and toxicity of these contaminants are also closely tied to the reduction/oxidation (redox) potential of the sediments and to the type and abundance of natural microorganisms. Highly chlorinated PCBs such as Aroclor 1268 require anaerobic conditions to begin dechlorination. However, the dechlorination will be very gradual, especially in marine environments with high chloride levels (U.S.EPA, 1998b). Sufficiently high concentrations of metals can also act to inhibit the microbial activity that breaks down the PCBs (Kannan, 1997). Mercury, as mentioned above, is more readily methylated under sulfate reducing conditions that modeling, etc.) to fully evaluate and assess the technology. These factors are chosen based on reviews of other Damage Assessment and Restoration Plans (DARPs) and are similar to the factors described in both the EPA's criteria for Superfund feasibility studies (U.S. EPA, 1988) and Title 43 of the Code of Federal Regulations (43 CFR) 11.82.

Evaluation Factors

1. Extent to which the alternative can return the injured natural resources to baseline
2. Extent to which the alternative will avoid or minimize additional injury to the natural resources
3. Level of uncertainty in the success of each alternative, including the developmental stage, ease of implementation, and/or examples of the technologies use and success at other similar locations
4. Relative cost effectiveness
5. Permanence, e.g. will it require continued institutional controls and monitoring
6. Community acceptance

2.2 On-Site Alternatives

Several sources of data were used to obtain a list of potential technology alternatives for addressing remedial/primary restoration actions. These included personal contacts with technical personnel in EPA, the U.S. Army Corps of Engineers, and searches of government and private organizations' publications and databases. The contacts, publications, and databases are listed at the end of this report.

The majority of the technology demonstration work conducted by the EPA as part of the Superfund Innovative Technology Evaluation (SITE) and other programs has not dealt with contaminated sediments (see U.S.EPA, 1994 and the REACHIT and RIMS2000 databases). Those few projects that have, have dealt exclusively with stockpiled sediments, i.e. sediments that have already been dredged or excavated from a site and dewatered. The EPA has only recently published its Contaminated Sediment Management Strategy (U.S.EPA, 1998a). There has been very little testing of in-situ treatment methods and the work conducted has been primarily on a pilot or demonstration scale (Reynolds, 1998).

In contrast, a considerable amount of work has been conducted on contaminated groundwater and soils. As mentioned previously, little information is available on the groundwater at the LCP site. There are a number of approaches available for remediating metals-contaminated groundwater (see the FRTR and GWRTAC publications reference). However, mercury, in general, is somewhat more problematic than other metals due to its strong tendency to form complexes and organomercury compounds. The simplest approach would involve pump and treat techniques which are applicable when containment is the primary goal. Some of the most promising alternative innovative treatment technologies include permeable reactive barriers, electrokinetic migration, and soil flushing. However, applications of these technologies have typically not addressed mercury contamination. Further data or investigations are needed to evaluate methods for implementing groundwater actions.

A large body of work on sediment remediation has been conducted as part of the EPA's Great Lakes National Program Office (GLNPO) Assessment and Remediation of Contaminated Sediment (ARCS) Program (U.S. EPA, 1994). In addition, considerable amount of work has been conducted in Canada, which has also focused, in large part, on the Great Lakes issues (see GLOBALtechs database reference). These efforts have produced a large number of new presented in the table are general costs (low, medium, high) and referred to these applicable ranges. The timeframes for implementing the restoration alternatives range from several months up to two years for containment and removal actions and to more than ten years for monitoring natural attenuation or treatment through bioremediation.

Table 1 Continued.
Primary Restoration Alternatives for Tidal Saltmarsh and Creek Sediments

Technology Area or Approach	Specific Processes/ Description/Example	Benefits	Limitations	Relative Cost/Additional Comments/ Requirements
In-Situ Techniques				
Capping	Engineered Controlled placement of multilayers with or without geosynthetic fabrics Typically applicable for deeper sediments. Long term effectiveness still being monitored. Plastic liner used on 0.5-acre shoal area for PCBs in Manistique River, MI as an interim measure. Multilayer cap of geogrid/gravel/sand used on 5 acre nearshore site for PCBs in Convair Lagoon, San Diego, CA (U.S. EPA, 1998b) AquaBlok (stabilizing mixture consisting of calcium bentonite, organic clays, gravel and polymers) 2.5-acre demonstration project on the Ottawa River, OH (PCBs) (AquaBlok web site)	- Reduces contaminant levels in water column as both soluble and sediment adsorbed compounds - Isolates contaminants from benthic environment - More permanent and rapid containment versus broadcast method or natural sedimentation approaches	- Does not remove contaminants - Would require some removal of existing sediments or raising the saltmarsh elevation – difficult to implement in areas with grasses - Will impact existing benthic ecosystem plus high uncertainty for re-establishing benthic ecosystem over cap - Installation could have additional injury effects similar to dredging - Not tested in a highly dynamic estuarine environment where it will be susceptible to erosion and eventual cap failure	- Low to medium cost range - Capping approaches, in general, will be more appropriate for subtidal zones including creeks and rivers. However, capping of these areas should not be addressed until up gradient contaminant sources are removed. - Would still require institutional controls and monitoring to ensure integrity is maintained. - Requires information on where groundwater discharge occurs.

Table 1 Continued.
Primary Restoration Alternatives for Tidal Saltmarsh and Creek Sediments

Technology Area or Approach	Specific Processes/ Description/Example	Benefits	Limitations	Relative Cost/Additional Comments/ Requirements
Containment	<u>Solidification/Stabilization</u> Process involves mechanically mixing the upper layers of sediments with stabilizing or solidifying agents. Typically uses cement, pozzolan, bentonite, or polymer based materials. Installation requires the use of containment structures such as cofferdams and caissons. Used on Fox River, WI with cofferdam and phosphate/magnesium oxide/limestone to fix lead contamination (Reynolds, 1998)	-Reduces contaminant levels in water column and transport through sediment suspension -More permanent than capping	-Does not remove contaminants -Saltmarsh damage and monitoring requirements similar to engineered cap or dredging -Loss of sediment from suspension during installation -Would require backfill and restoration	- Medium to high cost range - Requires information on where groundwater discharge occurs

Table 1 Continued.
Primary Restoration Alternatives for Tidal Saltmarsh and Creek Sediments

Technology Area or Approach	Specific Processes/ Description/Example	Benefits	Limitations	Relative Cost/Additional Comments/ Requirements
Treatment	<u>Bioremediation</u> Stimulate indigenous microbial activity with nutrients or introduction of "designed" micro-organisms Previous applications have dealt primarily with PAHs, which require aerobic conditions that are not applicable for mercury and PCBs Limnofix method successfully used at Dofasco Boatslip, Hamilton Harbor, Ontario (1 kilometer by 100 meter area) to inject calcium nitrate and organic amendments to enhance degradation (PAHs) (Reynolds, 1998; and OCETA database)	- Benefits similar to natural attenuation - Augmentation can increase the rate and effectiveness of attenuation	- Limitations similar to natural attenuation - Difficult to get proper mixing of nutrients and/or micro-organisms or maintain balance with tidal flows and sediment dynamics - Resuspension and loss of sediments on mixing - May disrupt existing ecosystem	- Low cost range - In general, in-situ treatment methods will be less efficient than ex-situ methods due largely to limitations on process controls including proper delivery and mixing - Mercury cannot be removed from the sediments through treatment, it can only be contained, fixed or transformed to reduce toxicity or mobility - Injection methods for deeper waters would have to be modified for tidal marsh

Table 1 Continued.
Primary Restoration Alternatives for Tidal Saltmarsh and Creek Sediments

Technology Area or Approach	Specific Processes/ Description/Example	Benefits	Limitations	Relative Cost/Additional Comments/ Requirements
Ex-situ Techniques				
Dredging	Mechanical Includes clamshell bucket, backhoe, bucket ladder, etc. Used at Bayou Bonfouca, LA (PAHs) followed by fill and Manistique River, MI (PCBs) (SMWG publication)	- Can remove most contamination	- Resuspension and dispersion of contaminated sediments - Construction of berms, walls and silt curtains difficult with high tidal currents – proper installation may require level of effort similar to dry excavation - Destruction of existing ecosystems	- Medium cost range - For all ex-situ techniques, the following processing steps would also be required prior to treatment or shipment: + stockpiling and segregation with respect to contaminant levels + dewatering with subsequent waste water treatment - Typical drawbacks to dredging, including site access and adequate space for sediment handling, are not an issue for the LCP site. - Typical systems employed in deeper waters would require modification/hybridization to work in shallow tidal and subtidal areas. - Significant advances have been made in all dredging applications to reduce sediment losses through the design of the dredgehead and through the use of containment barriers (U.S. EPA, 1994)

Table 1 Continued.
Primary Restoration Alternatives for Tidal Saltmarsh and Creek Sediments

Technology Area or Approach	Specific Processes/ Description/Example	Benefits	Limitations	Relative Cost/Additional Comments/ Requirements
Dry Excavation	Berm, dam or dike marsh areas and drain, excavate sediments and backfill, remove berms and dikes and replant Primarily used on inland waters and wetlands Used at Loring AFB, ME on channels and wetlands (Aroclor 1260 and PAHs) (SMWG publication)	- More efficient (e.g. reduce loss of sediments) and complete removal versus dredging techniques	- Destruction of existing ecosystems - Due to tidal flows, construction of berms and dikes likely to be time consuming and costly	- High cost range - Process similar to filling marsh with follow-up reconstruction - Can combine with in-situ or on-site treatment once marsh is drained

restoration approaches. In particular, capping or filling restoration alternatives could be impacted, or impact the existing ecosystem, if discharge is occurring in the region of the capped or filled area.

3 COMPENSATORY RESTORATION ALTERNATIVES

It is unlikely that EPA remediation or primary restoration will remove all of the known contaminants from the area. Even if all of the contaminants were removed, however, compensatory restoration would be required to make up for years of injury to trust resources. Compensatory restoration can be specific to an injured resource, such as the wood stork, or more general, such as restoration of a saltmarsh habitat. Most of the proposals included in this report are more general, in part because specific injuries to trust resources have not yet been determined.

3.1 Problem Definition

Areas impacted include highly contaminated saltmarsh south of the causeway (13 acres of which were actively remediated by EPA), unremediated saltmarsh north of the causeway, and adjacent saltmarsh with lower, but still significant levels of contamination. In addition, fish and seafood consumption advisories are in effect for the Turtle River above and below the LCP site, based on high levels of mercury and PCBs in tissue (Georgia Department of Natural Resources 1998 and 1999). The Turtle River is listed as "not fully supporting designated uses" due to the fish consumption guidance, shellfish ban, and dissolved oxygen levels (GADNR 1998). Federally and State listed special status species at the site include least tern (*Sterna antillarum*), wood stork (*Mycteria americans*), West Indian manatee (*Trichechus manatus*), and loggerhead sea turtle (*Caretta caretta*). Several other special status species may also occur in the area (NOAA, 1999). Levels of PCBs and mercury measured in prey from the site pose a risk to these top predators (U.S. EPA, 1997). Other trust resources have also been shown to be at risk from PCBs, mercury, and other contaminants at the site (U.S. EPA, 1997).

Tetra Tech prepared an annotated list of compensatory restoration alternatives based on conversations with representatives of GADNR and Coastal Zone Management Administration (CZMA), University of Georgia (UGA) Marine Extension Laboratories, and five nongovernment organizations (NGO) focused on environmental issues (see list associated with Table 2). Records of conversations are presented in Section 4.2; additional materials from the Glynn Environmental Coalition (GEC) are in Appendix A.

3.2 On-Site Alternatives

Opportunities for habitat enhancement exist in the north marsh to the right as you proceed down the earthen causeway. However, this area is also partially contaminated. It is possible that channels could be created in an uncontaminated portion of this marsh, to increase both edge and open water habitat at high tide, and to expose mudflats at low tide. Channels carry flood and ebb flows into and out of the marsh, and facilitate the movement of nutrients and organisms throughout the marsh (Zeff, 1999). Since the endangered wood stork feeds in the mudflats at low tide, creating of this habitat type would directly benefit this species. However, extreme care must be taken to ensure that sediment and prey in the newly exposed mudflats are not contaminated.

Although Tetra Tech did not discuss on-site restoration alternatives with the community stakeholders contacted for this project, the GEC submitted written suggestions that included a 400-foot-wide greenway, or buffer, on site. The proposal includes planting a dense line of oak trees at the edge of the upland habitat on site. A diagram of this proposal is in Appendix A. The

Table 2. Off-Site Compensatory Restoration Proposals

Project Name (Approximate Size)	Recommended by	Affiliation	Project Location (Proximity to Site)	Project Objectives	Potential Obstacles
Glynn County Public Works Equipment Area (2-3 acres)	Daniel Parshley	GEC	Adjacent to LCP site on southeast side (on Route 341)	Remove construction equipment and landfill materials, regrade to marsh elevation, revegetate with marsh plants. This would create 2-3 acres of marsh habitat adjacent to site, which could be enhanced with tidal channels.	County is actively using this site to store construction equipment. Contents of landfill are unknown, but potentially contaminated. The firing range likely contains lead in the soil.
Marsh Hammock Purchase (30-100 acres)	Stuart Stevens Randy Walker Daniel Parshley	GADNR / CZMA UGA GEC	"Visa Vis" owned by Georgia Pacific, and "Jointer" privately owned (Mr. Manning). (within 2 miles downriver from LCP)	Remove 30-100 acres of marsh hammocks from immediate development. Provide long-term maritime forest habitat for resident and migratory birds, and shoreline habitat for estuarine resources.	High cost of desirable areas; competition with other potential buyers.
Groundwater Recharge	Paul Christian Stuart Stevens Randy Walker Don White	UGA GADNR UGA CRCDC	Throughout Turtle River and Altamaha River area	Reduce groundwater draw downs by paper industry through education and public relations activities	Paper industry executives may not be motivated to make any changes to their typical procedures.
Restoration of Freshets and Water Banking	Daniel Parshley Paul Christian Don White	GEC UGA CRCDC	Throughout Turtle River and Altamaha River area	Reduce the current rate of fresh water flow through the rivers by increasing areas that will trap and hold surface water	Much of the potential area for water banking is privately owned; cooperation is required.

3.4 Preliminary Recommendations

It is premature to provide extensive evaluations and recommendations of preferred alternatives proposed thus far. For example, in many cases, ideas for land purchase were not coupled with suggestions for specific project locations. In other cases, the projects proposed are extremely far-reaching and complex. Instead of attempting to evaluate the merits of each proposed alternative against an external standard, Tetra Tech asked each representative to comment on their proposals. Through this process, potential strengths and weaknesses of proposal were made clear. Preliminary recommendations are based strictly on the general consensus of the group contacted for this report.

Two proposals had unanimous and enthusiastic support of the people contacted: (1) purchase of marsh hammocks and islands at risk of development, and (2) recharge of groundwater in the Brunswick area. These two alternatives address separate elements of the habitat, and require different levels of resources from trustee agencies. For example, land purchase calls for primarily financial resources, and generally requires only minimal research and coordination with other stakeholders. In contrast, the groundwater recharge issue is technically and logistically complex, involving understanding of hydrogeological processes in the area, coordination among government, commercial, and private sectors, and development of a monitoring plan acceptable to all parties. Despite the financial resources required to purchase land and the technical challenges of the groundwater recharge plan, both of these projects are considered viable compensatory restoration options.

The purchase of coastal land is essentially a financial transaction once the lands are selected. The land could then be held in perpetuity with several future options for use. The land could be (1) strictly left as is (preservation), with or without monitoring; (2) managed by NOAA, another agency, or an NGO for a particular resource; or (3) used for long-term research. Purchase of coastal land does nothing to restore already injured habitat, but it can serve to increase the function of lost or degraded habitat in the area and help reduce future habitat destruction that results from development. Land acquisition is most appropriate as compensatory restoration when it results in an increase in the net level of ecological services when the purchased lands are under immediate threat of development.

Promoting groundwater recharge requires the expertise of hydrogeologists, wetland ecologists, community relations professionals, and other specialists, such as industrial process engineers. The representatives contacted indicated that draw down of the aquifer was one of the most imminent threats to the overall health of estuarine resources. Historically, groundwater bubbled up beneath the river and estuary bottoms, an event known as "sweetening the water." This widely distributed influx of clear, cool fresh water served to regulate salinity in the area. In contrast, surface water discharging into the estuary through the rivers is highly turbid and laden with nutrients that may adversely affect estuarine resources. Currently, surface water tends to enter the estuary as discrete fresh water pulses, which can result in osmoregulatory stress to some invertebrate and fish species. Although the flow of rainfall into the river, and ultimately into the estuary, is a natural process, the rate of the freshwater pulses has increased in the past 50 years because of the increase in channelization and impermeable surfaces in areas upgradient from the estuary. Much of the rainfall that historically seeped into the ground and trickled into the river now rushes into the river through channels and culverts. These factors suggest that groundwater may be a critical source of freshwater to the estuary and essential to its long-term restoration.

4 PERSONAL CONTACTS AND ANNOTATED REFERENCES

4.1 Introduction and Primary Restoration Alternatives

Contacts:

Dennis Timberlake, U.S. EPA, National Risk Management Research Laboratory (NRMRL), Cincinnati, OH 45268; (513) 569-7547; Subject Area: general sediment remediation, Contacted 11/4/99

Member of Remediation Technologies Development Forum [RTDF], Sediments Remediation Action Team; RTDF was created by the EPA to foster collaboration between the public and private sectors; website: www.rtdf.org . The action team was only recently formed and is just initiating research activities. Recommended investigating Sediment Management Work Group website and mercury studies on sulfate-reducing bacteria conducted through National Center for Environmental Research and Quality Assurance (NCERQA) grants. Also recommended investigating natural processes, e.g. burial by cleaner sediments. Provided apparent effects threshold (AET) values for mercury. Recommended Paul Randall as an additional contact source.

Paul M. Randall, U.S. EPA, NRMRL, Cincinnati, OH 45268; (513) 569-7673; Subject Area: remediation of mercury contaminated sediments, Contacted 11/18/99.

Primary EPA research focus areas are on process wastes, including stockpiles of dredged sediments. Research has involved treatment with sulfides and phosphates to stabilize the mercury and microorganisms which will uptake and fix the mercury. Very little work has been done treating mercury in-situ, especially in tidal estuarine environments. Recommended contacting EPA Region 4 personnel involved with the Cold Creek site in Mobile, Alabama. Also recommended investigating the use of AquaBlok technology but was uncertain if it would be applicable in estuarine environment.

Other Potential Contacts:

Michael Arnett, U.S.EPA Region 4, (404) 562-8921
Recommended contact from Paul Randall. Is involved with mercury cleanup associated with Olin Corp. and Akzo Nobel facilities along Cold Creek near Mobile, Alabama.

Humberto A. Guzman, U.S.EPA Region 4, (404) 562-8896
Additional recommended contact from Paul Randall. He is also the EPA contact for the Community Based Environmental Project (CBEP) in Brunswick.

Norman R. Francingues, Jr., U.S. Army Engineer Research and Development Center, Vicksburg, MS 39180; (601) 634-3703; environmental effects of dredging programs

Mr. Francingues was contacted, however, it was not possible to discuss dredging alternatives with him prior to completing this report.

U.S. EPA, 1998a. EPA's Contaminated Sediment Management Strategy, Office of Science and Technology, Document No. EPA 823-R-98-001 (available at www.epa.gov/OST/cs/manage/stratndx.html).

U.S. EPA 1998b. Proceedings of the National Conference on Management and Treatment of Contaminated Sediments, Document No. EPA/625/R-98/001, Cincinnati, Ohio, May.

U.S. EPA, 1999a. Region 4 Waste Management Division; Georgia NPL Fact Sheets, Revised June 1 (available at www.epa.gov/region4/wastepgs/npl/nplga/lcpincga.htm).

U.S. EPA, 1999b. Contaminated Sediments News, Office of Water, Spring (available at www.epa.gov/ost/pc/csnews/).

Publications / Database Searches:

AquaBlok Composite Particle System, www.aquablokinfo.com

Environment Canada, National Contaminated Sites Remediation Program: Development and Demonstration of Site Remediation Technology (DESRT) Program, www.ec.gc.ca/desrt/
The DESRT Program is the Canadian counterpart to the U.S. EPA SITE Program

Federal Remediation Technologies Roundtable (FRTR), www.frtr.gov
A federal interagency working group consisting of the DoD, EPA, DOE, DOI, DOC, USDA, and NASA. Develops cost and performance reports from technology demonstrations.

GLOBALtechs, www.globaltechs.com , requires subscription (database not searched)
Database was created by merging two commercially available databases: SEDTEC and REMTEC. SEDTEC, the Contaminated Sediment Removal and Treatment Technologies Directory, was developed by Water Technology International Corporation for Environment Canada's Remediation Technologies Program (RTP). It contains over 250 sediment removal and treatment technologies. Additional sources of information on select technologies cited in the database include the Ontario Center for Environmental Technology Advancement (OCETA) (www.oceta.on.ca/) and the Canadian Center for Inland Waterways (CCIW) (www.cciw.ca/).

Groundwater Remediation Technologies Analysis Center (GWRTAC), www.gwrtac.org
Produces evaluation, overview, and status reports on general emerging technology approaches, e.g. In-situ Flushing, In-Situ Chemical Treatment, Electrokinetics, etc. based on case studies.

Remedial Technologies Network, Remediation Information Management System (RIMS2000™), www.enviroglobe.com , requires subscription
Technology based. Database search criteria included sediments contaminated with PCBs and heavy metals.

- Linda Harn, Unit Manager, Environmental Protection Division, Watershed Planning and Monitoring Program Intensive Surveys Unit, GADNR. (404) 675-1647.

Ms. Harn provided information and documents on the fish and seafood consumption advisories issued for the Turtle River area.

Glynn County Public Works Department

Larry Harper, Supervisor of Heavy Equipment. (912) 267-5760.

Mr. Harper answered queries about a 2-3 acre parcel of land on Route 341, adjacent to the LCP site, where his staff stores road-building equipment. He stated that the department does not dispose of any materials at this site, but that the area nearest the marsh was created by fill material, and may have once been used as a landfill. He agreed that this parcel could be enhanced for wildlife usage, but pointed out that there is also a firing range on the property. He suggested that I contact Mr. Mark Eckert, Glynn County Supervisor (912/554-7400), for more details on the property.

University of Georgia

- Randy Walker, Director for Marine Extension Service, University of Georgia. (706) 542-8849.

Mr. Walker listed water quality and water supply as the most serious threats to estuarine health in the Brunswick area. He voiced support for several previously mentioned coastal restoration concepts, including (1) ground water recharge, (2) purchase of marsh hammocks, and (3) cleaning up septic tanks that are contaminating shellfish beds. In addition, Mr. Walker expressed concern over a permit application for an industry consortium to take 1 million gallons of water per day from the Altamaha River. He had little information on the applicant or the details of the permit, but felt that any new distribution of that amount of water from the river would have an adverse effect of estuarine resources.

- Paul Christian, Public Service Assistant, University of Georgia Marine Extension. (912) 264-7268. Email: pchristi@arches.uga.edu

Mr. Christian feels that the economy of Brunswick is rapidly changing from industrial to tourism, and that changes in the attitudes and habits of people are necessary to preserve and restore the coastal area. He provided three recommendations, presented in the order of importance.

(1) Reduce the use of ground water by industry and of surface water by agriculture and municipal sources. His concern is that overuse of freshwater is allowing saltwater intrusion up the rivers. Saltwater intrusion degrades the water quality of the estuary and adversely affects estuarine and riverine invertebrates and fish. Ground water used to bubble up beneath the estuary, causing a "sweetening" of the estuary. When this freshwater "sweetening" is eliminated, fish experience osmoregulatory stress, resulting in slower growth. Mr. Christian indicated that these effects are well-documented in the scientific literature. His recommendation for addressing this problem is to work with the paper and pulp mills to promote water conservation, as a single mill uses 40 million gallons per day.

- Don White, Coastal Georgia Resource Conservation and Development Council (CRCDC). (912) 876-6485.

Mr. White is a soil scientist with the U. S. Department of Agriculture. The CRCDC is responsible for 319 projects. He is not particularly familiar with the Turtle River system or the Brunswick area, but had some general comments relevant to recommendations made by other parties. Mr. White also provided a facsimile of a contact list from a recent Altamaha River Research and Management Workshop, which follows this section.

Tetra Tech asked Mr. White to comment on previously submitted recommendations for coastal restoration, such as reducing ground water extraction and promoting water banking. He supported the reduction in ground water use, stating that a paper mill in the Augusta area was reported to use 45 million gallons of water per day. He thought that promoting water banking on silviculture plots may be reasonable, but that the Georgia Forestry Commission does best management practice compliance audits on the silviculture industry, and that overall compliance is around 90 percent. He indicated that the most important coastal enhancement project was cleaning up the septic systems along the coast, as many of them are leaking into ground water and surface water.

- David Kyler, Director. Coastal Georgia Center for Sustainable Development. (912) 437-8160.

Mr. Kyler was mentioned by several of the other contacts as an important resource in the area. He was contacted indirectly through Daniel Parshley, and sent an email expressing interest in this project. He participated in meetings with GEC at which proposed restoration activities were discussed (see Appendix A), but Tetra Tech never spoke to him directly.

- James Holland, Altamaha Riverkeeper, Chairman of the Board. (912) 264-6579

Tetra Tech made several attempts to contact Mr. Holland. He is a commercial crabber, and is difficult to reach by phone. He is apparently highly regarded in the Brunswick community, and several people mentioned him as an important source of ideas for this project. Mr. Holland was present at meetings of the GEC during which materials in Appendix A were prepared.

Other Potentially Useful Contacts

- Phil Flournoy, Program Manager, Coastal Zone Management and DNR. (912) 262-3198
  Mr. Flournoy works with Stuart Stevens, but is on leave until January 24, 2000.
- Dorset Hurley, Research Coordinator, Georgia DNR. (912) 485-2251. Email: dhurley@surf.nos.noaa.gov
- Mac Rawson, Ph.D., Director, Georgia Sea Grant Program. (706) 542-5954.
  Email: mrawson@arches.uga.edu.

  Dr. Rawson is interested in contributing his ideas on potential compensatory restoration projects, and requested an email message explaining the project. No response has yet been received.
- Mary Elfner, Coastal Georgia Land Trust. (912) 231-1143. Email cglt@bellsouth.net.

  Ms. Elfner is interested in contributing her ideas on potential compensatory restoration projects, and requested an email message explaining the project. No response has yet been received.

DELIBERATIVE PRE-DECISIONAL
CONFIDENTIAL
DO NOT RELEASE

Additional Potentially Useful Contacts
Altamaha River Research and Management Workshop

(Four Sheets)

502 General Stewart Way, Suite 6
Hinesville, GA 31313
912-876-6485 912-877-2021, fax
E-Mail: Coast@clds.net

Coastal Georgia RC&D Council

Fax

To: Ms. June Mire

From: Don White

Fax: 504-486-~~[illegible]~~ 0173

Pages: 5

Phone:

Date: 1/18/00

Re: Turtle River Projects

CC:

☐ Urgent ☐ For Order ☐ Please Comment ☐ Please Reply

• Comments: Attached are contact list from the Altamaha River Research & Management Workshop as you requested. Also attached is card for Dorset Hurley at the Sapelo Island National Estuarine Research Reserve who would also be a good contact for you. Good luck with your project. Please let me know if I can help.

Don White

Altamaha River Research and Management Workshop
Contact List

If you need more information about one of the topics discussed during the workshop, one of the following speakers may be able to assist you.

Dr. Merryl Alber
University of Georgia, School of Marine Programs
Athens, GA 30602
Water Use and Flushing Times in the Altamaha

Dr. Jack Blanton
Skidaway Institute of Oceanography
10 Ocean Science Circle
Savannah, GA 31411
(912)598-2457
Impact of Land Use Changes on Salt Regimes of Georgia Estuaries

Dr. David Braun
The Nature Conservancy
4245 N. Fairfax Dr., Suite 100
Arlington, VA 22203-1606
703-841-5300
dbraun@tnc.org
Altamaha River Hydrology

Dr. Alice Chalmers
University of Georgia, School of Marine Programs
Athens, GA 30602
Land Margin Ecosystem Research Project

Mr. Bert Deener
Wildlife Resources Division, GA Department of Natural Resources
P.O. Box 2089
Waycross, GA 31502
(912)285-6094
Shad on the Altamaha River

Mrs. Kyla Hastie
U.S. Fish and Wildlife Service
4270 Norwich Street Extension
Brunswick, GA 31520
(912)265-9336
USFWS Altamaha River Ecosystem Team

Mr. James Holland

Altamaha Riverkeepers
P.O. Box 2642
Darien, GA 31305
(912)437-8164
Altamaha Riverkeepers and Blue Crabs

Dr. Gene Keferl
Department of Natural Sciences and Mathematics
Coastal Georgia Community College
3700 Altama Avenue
Brunswick, GA 31525
(912)262-3089
Freshwater Mussels in the Altamaha

Mr. Rick Krause
U.S. Geological Survey
Peachtree Business Center
3039 Amwiler Road, Suite 130
Atlanta, GA 30360-2824
Groundwater and the Altamaha River

Mr. David Kyler
Coastal Georgia Center for Sustainable Development
P.O. Box 598
Darien, GA 31305
dksusdev@gate.net
Economic Implications of Water Issues

Ms. Christi Lambert
The Nature Conservancy of Georgia
P.O. Box 484
Darien, GA 31305
(912)437-2161
TNC Conservation Initiatives in the Altamaha River Watershed

Mr. Bob Lord
Region IV, U.S. Environmental Protection Agency
61 Forsyth Street, SW
Atlanta, GA 30303-3104
lord.bob@epa.gov
Data Needs of Resource Managers

Mr. Pete Maye
Environmental Protection Division
1 Conservation Way
Brunswick, GA 31520
(912)264-7284
Altamaha Water Quality

Satilla Management Services, Inc.
Route 2, Box 188
Waynesville, GA 31566
Shortnose and Atlantic Sturgeon in the Altamaha River System: Habitat Use, Status and Constraints on Recovery

Mr. Rob Weller
Wildlife Resources Division, GA Department of Natural Resources
Bowens Mill Fish Hatchery
1773-A Bowens Mill Highway
Fitzgerald, GA 31750
(912)426-5272
Flathead Catfish on the Altamaha

Mr. Phillip White
Environmental Protection Division
205 Butler St., SE
East Tower, Suite 1058
Atlanta, GA 30334
(404)657-8282
Altamaha River Basin Planning Initiative

Dr. Richard Wiegert
University of Georgia, School of Marine Programs
Athens, GA 30602
Human Impacts on Salinity in the Altamaha River

Mr. Brad Winn
Non-Game/Endangered Wildlife Program, Wildlife Resources Division, GA Department of Natural Resources
1 Conservation Way
Brunswick, GA 31520
Seabirds/Shorebirds in the Altamaha

Mr. Arnold (Spud) Woodward
Coastal Resources Division, GA Department of Natural Resources
1 Conservation Way
Brunswick, GA 31520
(912)264-7218
Seasonal Use of the Altamaha River Delta by Adult Red Drum

Ms. Barb Zoodsma
Non-Game/Endangered Wildlife Program, Wildlife Resources Division, GA Department of Natural Resources
1 Conservation Way
Brunswick, GA 31520
Manatee Use of the Altamaha

APPENDIX A

MATERIALS PROVIDED BY THE GLYNN ENVIRONMENTAL COALITION
(Single Set of Four Oversized Maps Were Included Under Separate Cover)

(Eleven Sheets)

Glynn
Environmental
Coalition, Inc.
Post Office Box 2443
Brunswick, Georgia 31521

January 21, 2000

June B. Mire, Ph.D.
Tetra Tech EM Inc.
6813 Louisville Street
New Orleans, LA 70124

Re: Summary of Coastal Restoration Projects for the Turtle River/St. Simons Sound estuary system.

Dear Dr. Mire,

Enclosed, please find three plats of Glynn County, soil type identification for Glynn County, aerial photos of Glynn County, and a receipt for the GIS plats. Using the enclosed materials, representatives of Altamaha Riverkeeper, Coastal Georgia Center for Sustainable Development, and Glynn Environmental Coalition met to further refine the areas needing restoration in the Turtles River basin. Since the modifications to the hydrology of the area are extensive, we decided to broadly identify the problems and suggest possible solutions. Further study will be needed before restoration plans can be implemented to restore the freshwater hydrology of the Turtle River basin. In short, we tried to identify the most critical problem areas.

The hydrology of the Turtle River drainage area was ditched, channeled, and canalled to allow silverculture. Areas that have been put into silveculture production will be impacted by efforts to return the area to its original hydrology. Areas that are currently inappropriate for silverculture can be identified with minimal effort and targeted for purchase in order to provide a buffer between upland activities and wetland areas. Suggestions for coordination with ongoing programs and projects are attached.

A solution that takes the interests and concerns of all parties into consideration will have the greatest chance of succeeding. I trust a plan that incorporates existing programs to foster "best management practices" for silverculture areas can be combined with any monies obtained to stimulate resource recovery.

Sincerely,

Daniel Parshley, Project Manager

Enclosures

Note: The following abstracts flow together to encompass a larger goal: to mitigate fresh water runoff, improve fresh-water marsh productivity (direct relation to fisheries production), and form a cooperative relationship with all stakeholder.

Abstract

The goal of this seven year project is to develop a comprehensive model of fresh-water flow, fresh water marsh/estuary, in coordination with a coastal change analysis program to assess current condition and improvements in coastal Georgia. Particular attention will be paid to wetland loss due to silverculture, agriculture, and coastal development; and potential restoration/recovery methods.

Project priorities will be documentation of fresh-water flow pattern in uplands and freshwater marsh/estuary, establish monitor stations for salinity, BOD/COD, and nutrient/biomass load and composition. Information generated will be used to identify areas for restoration/mitigation of reduced productivity while increasing seafood production and minimizing decreases in current upland productivity.

Funding
- Section 319 National Monitoring Program
- National Estuary Program (FY 98 $12.7 million)
- Wetland, Coastal, & Water Quality Grants Branch
- Fisheries Development and Utilization Research and Development Grants and Cooperative Agreements Program (FY 98 $4 Million)
- Coastal Service Center Cooperative Agreements (FY 98 $2 million)

Abstract

The goal of this five year project is to implement a cooperative agreement between the State of Georgia and forest product producers for fresh-water marsh/estuary restoration while minimizing potential impacts to upland production. Restoration of water flow/retention patterns, wetland nutrient production, and subsequently the quantity of recreational and commercial viable species dependent on brackish waters. Pilot projects will field trial control structures and land use changes (Wetlands Reserve Program) and Environmental Quality Incentives Program). This conservation project will implement conservation programs that fully reflect local needs and priorities.

Funding
- Environmental Quality Incentives Program (1996 Farm Bill Conservation Provisions, NRCS (USDA))
- Wetlands Reserve Program (1996 Farm Bill Conservation Provisions, NRCS (USDA))

Coastal Resources Division
Coastal Management Program

COASTAL INCENTIVE GRANT
APPLICATION

APPLICANT	R. Wiegert[1], M. Alber[1], A. Chalmers[1], J. Blanton[2]
ORGANIZATION	[1]Department of Marine Sciences, University of Georgia [2]Skidaway Institute of Oceanography
ADDRESS	220 Marine Sciences Building University of Georgia Athens, GA 30602-3636
NAME/PHONE # OF CONTACT PERSON	Richard Wiegert, (706)542-1661
CATEGORY	☒ Coastal Water-Related Resources ☐ Critical Local Need
PROJECT TITLE	Human impacts on the salinity regimes of coastal Georgia estuaries.
PROJECT SUMMARY (25 word limit)	We will evaluate how changes in land and water use patterns have impacted the timing and amount of freshwater input, and consequently estuarine salinity and community structure, in coastal Georgia. ☐ Construction ☐ Non-Construction
PROJECT AREA	Central Georgia Coast
TIME FRAME	Start Date 3-1-1998 / End Date 2-28-2001
BUDGET SUMMARY	Amount Requested $91,681 (multi-year proposal: see budget page) / Match $40,331

97 DEC 29 PM 1:22

December 16, 1999

June Mire

Re: Summary of Coastal Restoration Projects for the Turtle River/St. Simons Sound estuary system.

Introduction

The Turtle River/St. Simons Sound (TRS) estuary system has been impacted by hydrological changes that have reduced or changed flow pattern and nutrient loading. Compounding the problems in the TRS area are releases from industries, some of which are now Superfund Sites. Restoration of the TRS estuary will need to include restoration of the historical hydrology and nutrient loading, reduction in toxic chemical loads, removal of accumulated toxic wastes, and monitoring recovery indicators. The goal of these activities is the restoration of the form and function of the estuarine ecosystem. (Note: Some of the items within should be done as part of the LCP Chemicals Superfund Site, and some are restoration specific projects. How the activities at the LCP Site affect the suggested restoration projects herein should be maintained.)

Hydrology

Restoration Project Number One

The Problem

Historically, the floodwaters from the Altamaha River flowed as a sheet across coastal freshwater wetlands into the TRS estuarine system. Critical nutrients that feed all trophic levels of the ecosystem have been blocked by road construction, development, and silviculture. Waters that once served as a feeding and flushing mechanism for the TRS system are now diverted or channeled. When rain events do occur, the natural slow release of freshwater and nutrient loading that historically occurred has been changed to a "pulse flow".

Unnatural rapid introduction of freshwater to the TRS ecosystem results in a three-fold problem. First, salinity ranges critical for early developmental life stages are shifted radically. Not all species dependent on a narrow salinity range have the capacity to make rapid and distant moves, resulting in reduced recruitment. Second, the loss of metered flow from freshwater wetlands results in reduced salinity further inland than were historically present. The areas where proper salinity does occur for developmental stages are reduced in area, thus reducing available habitat and food supply. Third, pulse flow is not conducive to nutrient loading of the freshwater entering the estuary and increases turbidity. Reduction in nutrients has a direct affect on the available food supply for all trophic levels.

The reduction or elimination of historical freshwater flow to the TRS allows discharged contaminants to accumulate within the estuary. The natural "flushing" action of the estuary has been disrupted. Pulse flows, a rapid "flushing", are followed by period of stagnation and contaminant loading.

The Solution

The historical and natural sheet flow from the Altamaha River, across the freshwater wetlands, needs to be restored to the maximum extent possible. Restoration efforts should include acquisition of freshwater wetlands, silviculture areas within these freshwater wetlands, and easements where needed to connect a contiguous flow to the TRS area. Restoration of the freshwater flow will include passage of freshwater under Route 341, which is acting as a dam between the Altamaha River and the TRS area. Areas that have been ditched to facilitate drainage will need to be filled.

Recovery of the TRS system is dependent on restoration of the historical hydrology of the area. Where potential non-point pollution is expected to be a problem, retention areas will be needed. Capacity deficiencies in the original freshwater wetlands can be compensated by metering the flow from areas needing retention of freshwater flow from ditching, flood control for developed areas, or control of non-point pollution sources.

Restoration Project Number Two

The Problem

The historic hydrology of the upper reaches of the Buffalo Swamp have been disrupted by State Highway 99, silviculture, and development. The problems identified in Restoration Project Number One apply to this area and will not be restated.

The Solution

The historical and natural sheet flow across the freshwater wetlands needs to be restored to the maximum extent possible. Restoration efforts should include acquisition of freshwater wetlands, silviculture areas within these freshwater wetlands, and easements where needed to connect a contiguous flow to the TRS area. Restoration of the freshwater flow will include passage of freshwater under State Highway 99, which is acting as a dam.

Restoration Project Number Three

The Problem

Unsuitable development of the marsh hammocks is taking place at an alarming rate. Areas that were once refuges for migrating birds and wildlife are now sought after for exclusive homes that are being built on clear-cut back-filled land that is devoid of any native plant species or habitat. Further impacting the estuary are the bridges being built to access the hammocks. What once were a refuge from high spring tides are now surrounded by walls that block access to high ground.

The Solution

With all due urgency, marsh hammocks should be acquired and set aside for perpetuity. (If the few undeveloped marsh-side lands and hammocks are not preserved, restoration of the form and function of the TRS ecosystem will not occur.) Along with the greenway at the LCP Site (below: LCP Restoration Project Number Four), these purchases of land should be a priority.

LCP Chemical Superfund Site

Restoration Project Number One

The Problem

The LCP Chemical Superfund Site (LCP) presents several problems to the TRS estuarine system. Even though remedial activities have been conducted, expansive areas of contamination exist. Further complicating the problems with the LCP site is the upcoming dredging of the Brunswick Harbor. Undoubtedly, contamination currently retained in the sediments will be reintroduced into the TRS ecosystem and sediments will be disturbed and transported to new locations as a result of changed hydrology.

The Solution

All stakeholders involved with the LCP Site, the Army Corps of Engineer, and the Georgia Ports Authority, need to evaluate potential impacts from the upcoming dredging project. Even though there will be an increase in levels of contaminants in seafood and wildlife, the dredging of the harbor does present an opportunity to permanently remove known areas of contaminants of concern (COC) from the ecosystem. Effort should be made to identify all areas of COC and target these areas for removal during dredge operations. In addition, the potential for sediment movement and re-deposition due to hydrological changes should be analyzed to minimize transport and reintroduction of COC that would otherwise remain "locked-up" in undisturbed sediments. Sufficient data has been gathered during the EPA Community Based Environmental Project (CBEP), LCP remediation, and previous NOAA research, to indicate that the TRS will not recover to any appreciable extent unless these known areas of COC are removed.

Restoration Project Number Two

The Problem

The TRS system is interconnected with the Jekyll Sound system at Joiner Creek. Within Joiner Creek is a State of Georgia oyster harvesting area. To date, only fecal contamination has been considered when evaluating the edibility of oysters from the Joiner Creek area.

The Solution

Since this area is susceptible to contamination from the COC in TRS area, testing and analysis is needed to quantify COC and ascertain if oysters from this area pose a human health risk. This testing and analysis will be needed before, during, and after harbor dredging operations.

Restoration Project Number Three

The Problem

No ongoing program has been conducted to quantify any restoration/degradation of the TRS ecosystem. Without the use of representative species, quantification of any restoration/degradation will not be possible. The form and function of the TRS ecosystem can not be analyzed without some measurement of representative species through sampling and analysis, community counts, and range determinations.

The Solution

Representative species from mammalian, reptile, avian, pisces, and invertebrate must be selected for monitoring of TRS ecosystem restoration/degradation. The following are representative species suggested. An explanation of why these species should be used is included with each species suggested.

Mammalian

Mink - The mink is a sensitive species to the COC present in the TRS ecosystem. At one time, mink were found throughout the TRS area, but is now absent from much of the TRS ecosystem. Being at the top of the food chain, the mink is a good indicator for other carnivores in the TRS ecosystem. Without the mink, the form and function of the ecosystem will not be complete.

Reptile

Diamondback Terrapin - Data has been collected on diamondback terrapin residing within the TRS area. Levels in some tissues and eggs were so high as to be classified as hazardous waste. Currently, the diamondback terrapin is listed as a food species in the State of Georgia. With the influx of immigrants that traditionally consume turtles in their diet, the potential does exist for harvest in the future. With the prohibition on sea turtle harvest, the likelihood of the diamondback terrapin being targeted is increased.

Avian

Marsh Hen - Data has been collected on marsh hen within the TRS and near the LCP Site. The marsh hen is a species that is harvested within the TRS area. With the potential to move outside the known areas of contamination, risk to consumers is increased.

Pisces

Spotted Seatrout - The spotted seatrout has been studied in the past and is sporadically studies by the State of Georgia. Being an important recreational species, the sea trout is consumed by recreational and subsistence fishermen. Data collected by the Georgia Department of Natural Resources in the 1980's showed an 18.8% rate of reproductive abnormalities, compared to 1/2000 to 1/3000 rate outside the TRS area. The reproductive abnormalities are consistent with known endocrine disrupting chemicals that occur in large amounts at the LCP site and within the TRS area.

Invertebrate

No recommendation.

Restoration Project Number Four

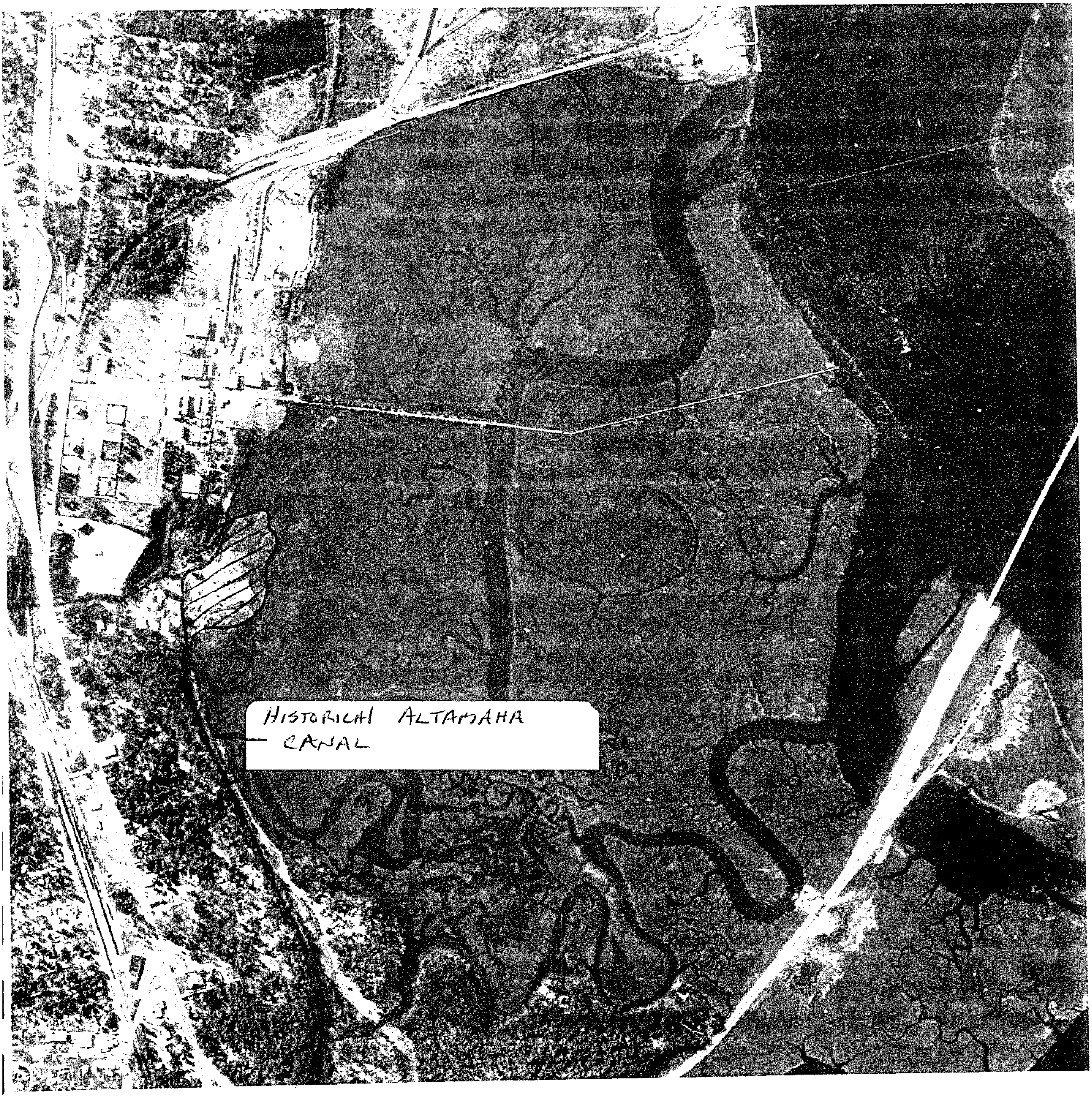
The Problem

During the operation of the LCP facility, contamination was discharged to the estuary from point and non-point discharges. Future use of the property will be for industrial uses, also. The potential for additive contamination to the marsh and estuary from upland sources when the property is utilized for industrial purposes threatens resource recovery.

The Solution

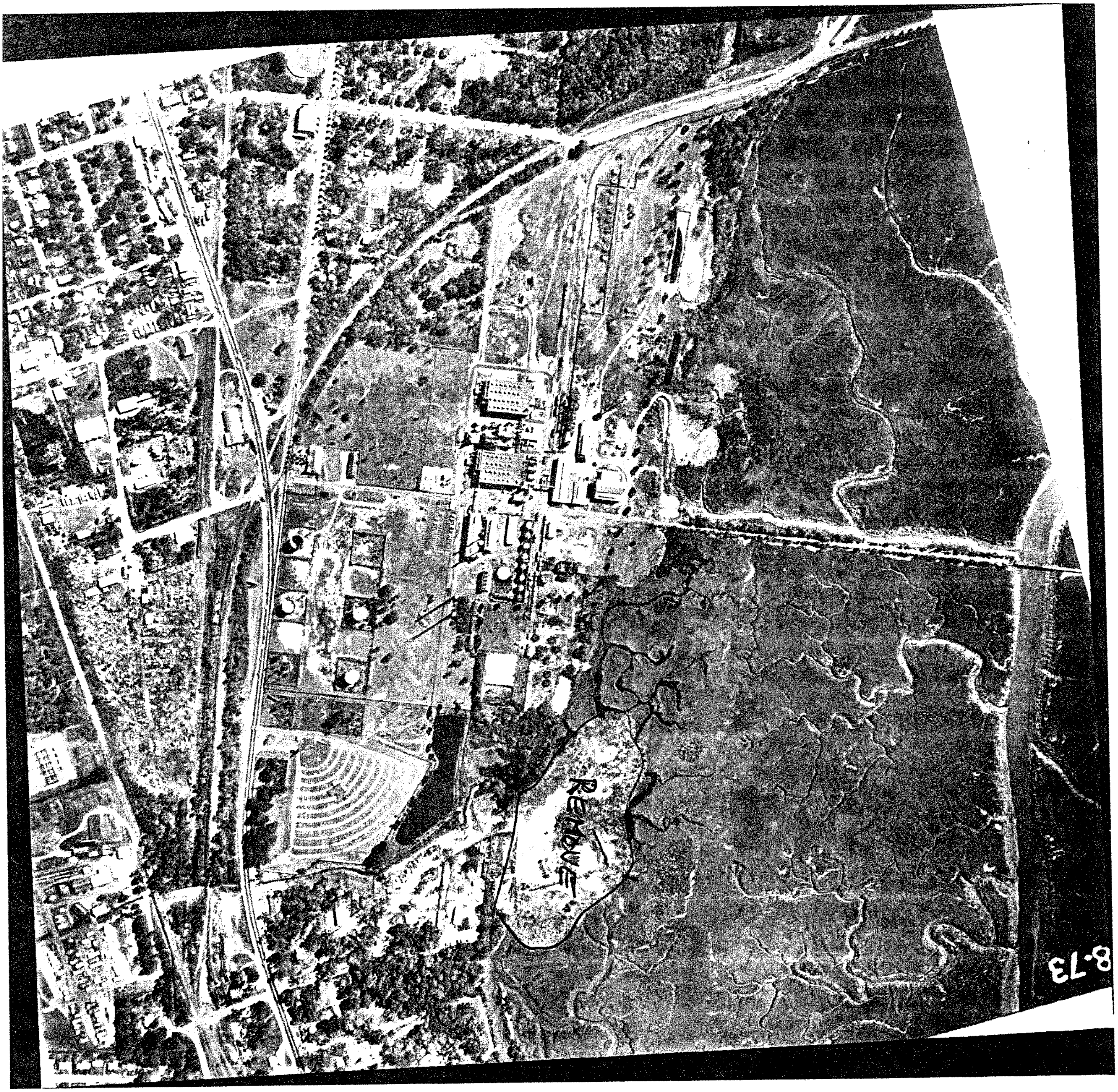
In order to protect the marsh and estuary that has been already impacted from past industrial operations at the LCP Site, a greenway (buffer) should be established along the entire length of the site where it adjoins the marsh. This buffer should be a minimum of 400 feet in width and incorporate the on-site pond. Effort should be made to include areas extending from Academy Creek to the South, and extend North to Buffalo Swamp. All undeveloped land should be acquired to prevent any further impact from non-point sources. In addition, live oak trees should be planted at the upland border of the LCP greenway as a "testament" to the boarder of this buffer area. Any clearing past the line of oak trees should be expressly prohibited. Consideration should be given to donation of the land to Glynn County, with an irrevocable covenant stating that it will remain in a natural state in perpetuity (and with no exceptions for access to build a deepwater dock!).

FYI.



GREEWAY/BUFFER

REMOVE



LCP SITE

Key
GREENWAY/BUFFER
LIVE OAK TREES